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CALCULATION SHEETS	PREP'D	N.V.A.	
	CHK'D	J.V.G.	
	APP'D	Y.S.C.	

CALCULATION SHEETS

FOR THE

FOUNDATION FOR TANK T-5101

SHELL GODAU LOBP PROJECT

SHELL CODAMO VIETNAM CO. LTD.

REV.	DATE	PAGE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15.02.2000	ALL	FOR INFORMATION	N.V.A.	J.V.G.	Y.S.C.
0a	10.03.2000	ALL	FOR APPROVAL	N.V.A.	J.V.G.	Y.S.C.

CONTENTS

1.0 GENERAL

1.1 Notes

This calculation sheet was made to prove the safety of the **Foundation for Tank T-5101** in the Shell Go Dau LOBP Project for Shell Codamo Vietnam Ltd. in GoDau, DongNai Province, Viet Nam.

1.2 The calculation is executed based on BS 8110 for the concrete structure. The symbols on this calculation sheet are made in accordance with BS 8110, for the concrete structure, unless noted otherwise.

1.3 Loads and Load Combinations

Design load and condition shall be as per specification S-00-1310-001. Attached Table-1 and Table-2 are the load combination tables, which are considered in these calculation sheets.

1.4 Characteristics of Materials

1.4.1 Concrete

BS 8110 Grade 30 (fcu=30 N/mm^2)

1.4.2 Reinforcement

High Yield Deformed Bar	:	TCVN-1651 : 1985	Grade CIII 392 N/mm²
Plain round Steel bar	:		Grade CI 216 N/mm²

1.5 Safety Factor for Foundation Stability

Load Combination	Overturning	Sliding	Uplift
A, B, C, H, I, J, K	2.00	1.50	1.10
D, F	2.00	1.50	1.10

1.6 Design Data

1.6.1 Unit Weight

Concrete	23.5	kN/m^3
Soil	18.0	kN/m^3
Ground Water	10.0	kN/m^3

1.6.2 Friction Coefficient

Concrete to soil	0.4

1.6.3 Coefficient of Earth Pressure

Ka	=	0.33	(active)
Kp	=	3.00	(passive)
Kr	=	0.50	(at rest)

Table -1 : Load Combination for Serviceability Limit State

- For calculation for selection of pile numbers, foundation stability, deflection and crack width of concrete structure

- For calculation for deflections of steel structures

Load combination		Operating Condition			Erection	Hydro-stactic Test	Bundle Pulling	Startup and Shutdown	Crane Operation Condition	
		+ Imposed	+ Wind	+ Imposed + Wind	+ Imposed + Wind	+ Wind			+ Imposed	+ Imposed + Wind
Load components		A	B	C	D	F	H	I	J	K
Dead Load	D	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Equipment Load	E	-	-	-	1.0	-	1.0	-	1.0	1.0
Operating Load	O	1.0	1.0	1.0	-	-	-	1.0	-	-
Imposed Load	L	(3)	-	(4)	(3)	-	(3)	(3)	(3)	(3)
Tube Bundle Pulling Force	B	-	-	-	-	-	1.0	-	-	-
Thermal Anchoring	Ta	1.0	1.0	1.0	-	-	-	1.0	-	-
and Friction Force	Tf	-	-	-	-	-	-	1.0	-	-
Thermal Sliding Load	Ts	1.0	-	-	-	-	-	1.0	-	-
Test	F	-	-	-	-	1.0	-	-	-	-
Crane	I	-	-	-	-	-	-	-	1.0	1.0 (2)
Dynamic Load	J	1.0	-	1.0	-	-	-	-	-	-
Earth and Water Pressure	H	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Wind Load	W	-	1.0	0.8	0.5 (1)	0.5 (1)	-	-	-	1.0 (2)

Notes: (1) 50 percent of full wind load to be applied.

(2) Only the greater effect of either crane load or wind load shall be applied.

(3) Factor 1.0 or 0, whichever is unfavorable.

(4) Factor 0.8 or 0, whichever is unfavorable.

Table -2 : Factored Load Combination for Ultimate Limit State

- For stress of concrete structures.

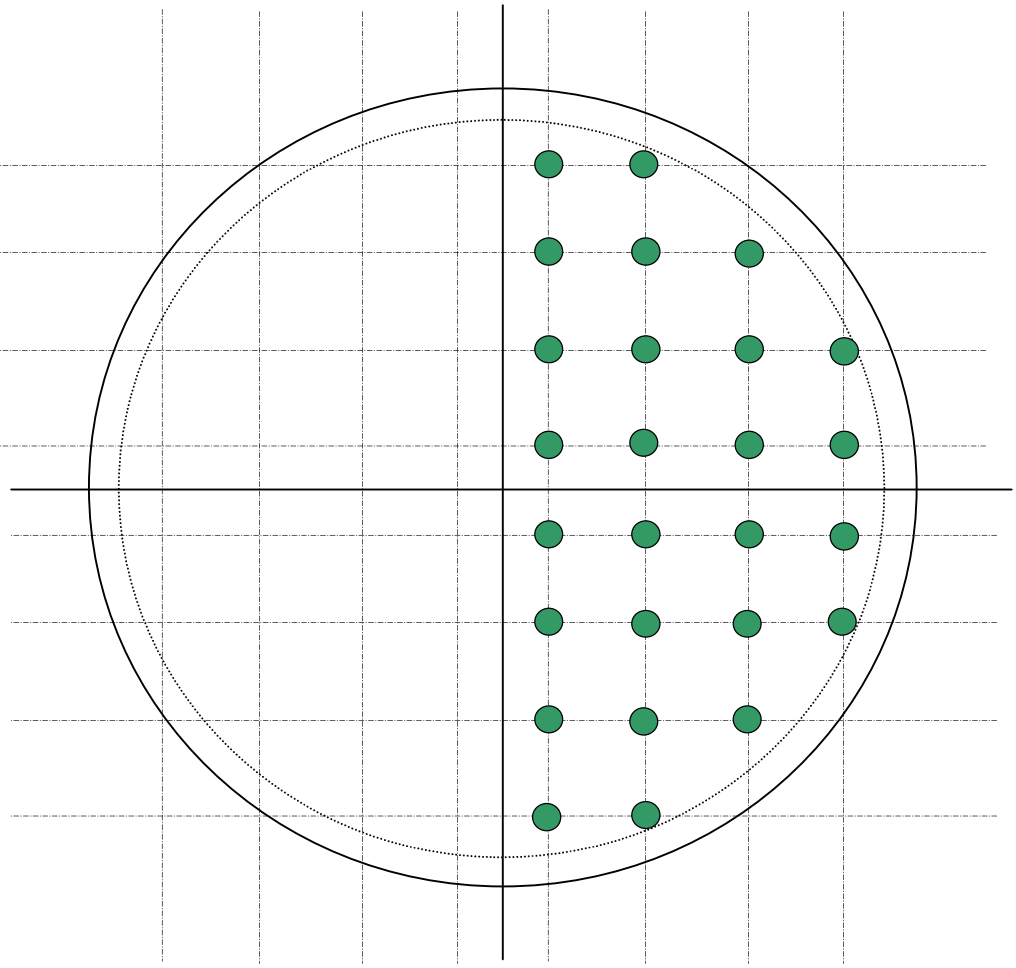
- For calculation for strength of steel structures.

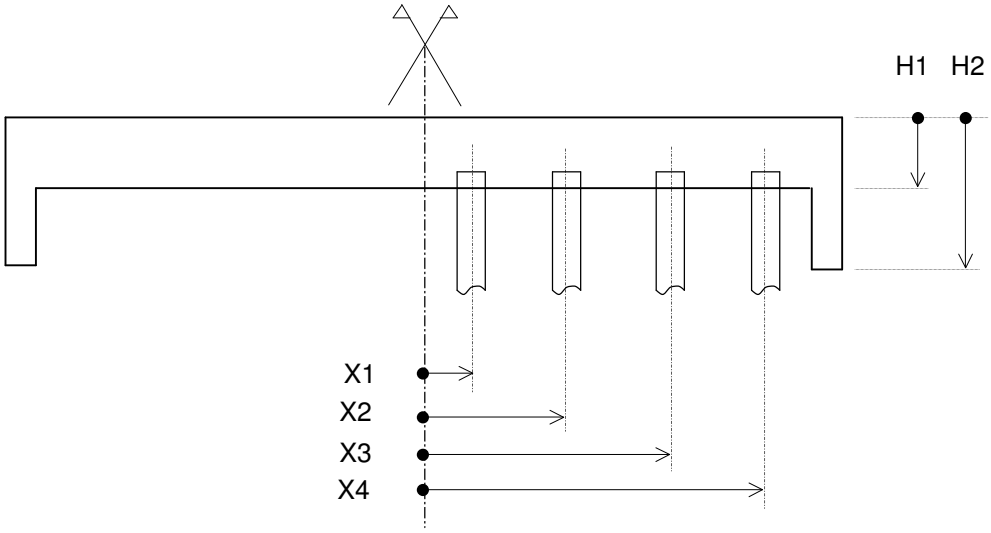
Load combination		Operating Condition			Erection	Hydro-stactic Test	Bundle Pulling	Startup and Shutdown	Crane Operation Condition	
		+ Imposed	+ Wind	+ Imposed + Wind	+ Imposed + Wind	+ Wind			+ Imposed	+ Imposed + Wind
Load components		A	B	C	D	F	H	I	J	K
Dead Load	D	(1)	(1)	1.2	(1)	(1)	(1)	(1)	1.2	1.2
Equipment Load	E	-	-	-	(1)	-	(1)	-	1.2	1.2
Operating Load	O	(1)	(1)	1.2	-	-	-	(1)	-	-
Imposed Load	L	(2)	-	(8)	(2)	-	(3)	(2)	(2)	(8)
Tube Bundle Pulling Force	B	-	-	-	-	-	1.0	-	-	-
Thermal Anchoring	Ta	1.2 (6)	1.2 (6)	1.2 (6)	-	-	-	1.2 (7)	-	-
and Friction Force	Tf	-	-	-	-	-	-	1.2	-	-
Thermal Sliding Load	Ts	1.2	-	-	-	-	-	1.2	-	-
Test	F	-	-	-	-	(1)	-	-	-	-
Crane	I	-	-	-	-	-	-	-	(3)	1.2 (5)
Dynamic Load	J	1.0	-	1.0	-	-	-	-	-	-
Earth and Water Pressure	H	1.4	1.4	1.2	1.4	1.4	1.4	1.4	1.4	1.2
Wind Load	W	-	1.4	1.2	1.4 (4)	1.4 (4)	-	-	-	1.2 (5)

Notes:
(1) Factor 1.4 or 1.0, whichever is unfavorable.
(2) Factor 1.6 or 0, whichever is unfavorable.
(3) Factor 1.0 (for vertical of horizontal load acting) or 1.4 (for both vertical and horizontal loads acting)
(4) 50 percent of full wind load to be applied.
(5) Only the greater effect of either crane load or wind load shall be applied.
(6) Ta corresponding to operation condition to be applied.
(7) Ta corresponding to start up and shut down condition to be applied.
(8) Factor 1.2 or 0, whichever is unfavorable.

2.0 OUTLINE OF STRUCTURE

DESIGN OF PILE CAP | Tank Foundation - T 5101 | 09-Mar-00





3.0 INPUT DATA

Tank

Dia.	dia =	12.5	m
Height	h_tank =	17	m
Wall thickness	t1 =	0.015	m
Top cover thickness	t2 =	0.01	m
Bottom plate thickness	t3 =	0.025	m

Pile

Pile size	d =	0.35	m	P(allow.)	739	kN		Ix	Spacing
				V(allow.)	66	kN			
	X1 =	1	m	No. X1	12	No.		12.0 m^2	2
	X2 =	3	m	No. X2	12	No.		108.0 m^2	
	X3 =	5	m	No. X3	8	No.		200.0 m^2	
	X4 =		m	No. X4		No.		0.0 m^2	
	X5 =		m	No. X5		No.		0.0 m^2	
	X6 =		m	No. X6		No.		0.0 m^2	
	X7 =		m	No. X7		No.		0.0 m^2	
				Total	32	No.	Ix	320	

Pile Cap

Diameter of Pile cap	D1 =	13.2	m
Thickness of Pile cap	H1 =	0.50	m
Top reinforcement	d1 =	16	mm
Bottom reinforcement	d2 =	16	mm

Ring beam

Height of ring beam	H2 =	0.9	m
Width of ring beam	b2 =	0.4	m

Check for Pile	Check for Pilecap (shear)
Safe	Safe

Material

Concrete	fcu =	30	Mpa
Reinforcement	fy =	390	Mpa

4.0 LOAD CALCULATION

Equipment load (Vertical Tank)

1 Empty weight

Steel weight

wall part	= 9.81*7.85*(dia.*π*h_tank)*t1		=	771	kN
Top & bottom part	= 9.81*7.85*(π*(dia)^2/4)*(t2+t3)		=	331	kN
		Sub-total	=	**1,102**	kN

Concrete weight

Slab + Ring beam	=24*(π*(D1)^2/4*H1+(π*(D1^2-(D1-2*b2)^2)/4*(H2-H1))			1797	kN
		⟶ Empty weight	=	**2,899**	kN

2 Operating weight

Liquid weight

Volume of tank

part 1	= π*(dia^2)/4*(h_tank-0.5)		=	2,025	m^3
		Sub-total	=	2,025	m^3
	γ = 1 ⟶	Liquid weight	=	**19,864**	kN
Issulation weight	= 0.5 T/m3				
(5cm thk)	= 0.5*((dia+2*t1)*π*h_tank)*0.05*9.81		=	164	kN
Operating weight	= Liquid weight + inssulation weight		=	**20,028**	kN

3 Test weight

	γ = 1 ⟶	Liquid weight	=	19,864	kN
Operating weight	= Liquid weight + inssulation weight		=	**20,028**	kN

4 Wind load, W

Wind pressure, **w = Cf*qz*Ae**

Cf	- factor		=	0.80	
qz	- basic wind pressure	for operating case	=	499.46	N/m^2
		for empty case	=	268.80	N/m^2
Ae	- Surface =1.2*(dia*h_tank)		=	255.00	m^2
	⟶	W (oper.)	=	**102**	kN
		W (emp.)	=	**55**	kN

Moment caused by wind load at top of pilecap

M	= W*(h_tank/2)	M (oper.)	=	**866**	kNm
		M (emp.)	=	**466**	kNm

5 Earthquake load, V (based on UBC 1994)

Base shear, $V = (Z*I*C/R_w)*W_t$

where

Z, zone factor		Z =	0.10	
I, importance factor		I =	1.25	
C, numerical coefficient $=(1.25*S) / (T)^{2/3}$; C <= 2.75				
S, site coefficient		S =	1.00	
T, fundametal period of vibration = $C_1*(h_n)^{3/4}$				
C_1, numerical coefficient		C_1 =	0.05	
h_n, height of structure above the base		h_n =	17.00	m
T =		T =	0.41	
C = 2.3 ; C > 2.75 then C= 2.75				
R_w, factor for non-building structure		R_w =	3.00	
W_t, weight of structure	for operating case	W_t =	21,130	kN
	for empty case	W_t =	1,102	kN
	for operating case	V (oper.) =	**1,999**	kN
	for empty case	V (emp.) =	**104**	kN

5.0 STABILITY CHECK

Loading data

(At top of pilecap)

LOADING CONDITION	N kN	Mx kN.m	Hx kN
Empty	1102		
Field test	20028		
Operating	20028		
Erection	551		
Wind load (operating)		866	102
Wind load (empty)		466	55
Base shear (earthquake load) (oper.)			1999
Base shear (earthquake load) (empty)			104

Loading data

(At bottom of pilecap)

LOADING CONDITION	N kN	Mx kN.m	Hx kN
Empty (incl. Pilecap weight)	2899		
Field test	20028		
Operating	20028		
Erection	551		
Wind load (operating)		917	102
Wind load (empty)		494	55
Base shear (earthquake load) (op.)		999	1999
Base shear (earthquake load) (em.)		52	104

Load combinations

(At bottom of foundation)

LOAD COMBINATION	N kN	Mx kN.m	Hx kN
A: Operating w/o wind	22,926	-	-
B1: Operating w/wind	22,926	917	102
B2: Empty w/wind	2,899	494	55
D1: Erection w/wind	3,449	917	102
F1: Hydrostatic test w/wind	22,926	917	102
L1: Operating at earthquake	22,926	999	1,999
L2: Empty at earthquake	2,899	52	104

Stability check

Pile diameter = 0.35 m
P allowable = 739 kN
V allowable = 66 kN
Ix = 320 m2

Load combination	Pile reaction								
	P_{max} kN	$P_{allow.}$ 739 kN		P_{min} kN	$P_{allow.}$ >= 0		$P_{lat'l.}$ kN	$P_{allow.}$ 66 kN	
L.C. A	716.5	safe		716.5	safe		0.00	safe	
L.C. B1	730.8	safe		702.1	safe		3.18	safe	
L.C. B2	98.3	safe		82.9	safe		1.71	safe	
L.C. D1	122.1	safe		93.5	safe		3.18	safe	
L.C. F1	730.8	safe		702.1	safe		3.18	safe	
L.C. L1	732.1	safe		700.8	safe		62.46	safe	
L.C. L2	91.4	safe		89.8	safe		3.26	safe	

6.0 DESIGN OF PILECAP

beff = $dp + 2*d_{eff}$ = 1.334 m

where dp = 0.50 m

d_{eff} = 0.417 m

Distribution pressure

Concrete	= 24*spacing*dp	=	24 kN/m
Liquid Press.	= 9.81*spacing*h_tank	=	334 kN/m
	Sub-total w	=	358 kN/m

M(top)	=w*spacing^2/10	=	143 kNm
M(bot)	=w*spacing^2/12	=	119 kNm

For 1m width

M(top)	=	107 kNm
M(bot)	=	89 kNm

For 1m width		Req'd		Minimum		Prov'd	
As(top)	=	1117	mm^2	542	mm^2	1117	mm^2
As(bot)	=	931	mm^2	542	mm^2	931	mm^2

As(top)	D =	16	mm	⟶	spacing	180 mm
As(bot)	D =	16	mm	⟶	spacing	216 mm

Shear stress at pile face — Safe

Area of pile face

$Ap = (4d_{pile})d_{eff}$ = 0.58 m^2

Punching shear

$V_U = 1.4Pmax$ = 1024.9 kN

Shear stress at pile face

$= V_U / Ap$ = 1.76 N/mm^2 ⟶ ratio = 0.40

$0.8\sqrt{f_{cu}}$ = 4.38 N/mm^2

Punching shear check — Safe

Allowable shear stress 0.43 Mpa

Area within perimeter

$Ap = (4*d_{pile}+8*1.5*d_{eff})*d_{eff}$ = 2.67 m^2

Punching shear stress

$= V_U / Ap$ = 0.38 Mpa ⟶ ratio = 0.89

Appendix : Mx Contour Stress

Due to supports are pile with dimention of 350x350 mm We try to locate the maximum Moment via stress contour → Maximum is 80.56 kNm/m < 107 kNm/m as our excel file → Pass for Plate bending.